HEALTHIER CEREAL PRODUCTS: BREADMAKING WITH BARLEY FLOUR
Promote consumption of barley breads, in order to improve intake of fibre and health-enhancing components

- Instrumental evaluation of barley substituted wheat dough
- Bread-making performances of flours
- Instrumental evaluation of breads
- Sensory consumer evaluation of breads
**Health promoteive compounds of barley**

- **Non-starch polysaccharides (NSP)**
  - *(1→3,1→4)-β-D-glucan*
    - 4-10% Holtekjølen et al (2005)
    - 3-11% Holtekjølen et al (2006)
  - **arabinoyxylans (AX):**
    - 7-16% (Holtekjølen et al, 2006)

- **Proanthocyanidins**
- **Phenolic acids**
- **Minerals**
- **Antioxidants**

**High contents of β-glucans barleys: suitable for functional food products**

- Blood glucose lowering effect
- Increase the viscosity of intestinal fluid and thereby reduce the rate of sugar/starch absorption
- Lower blood cholesterol level and, therefore, reduce the risk of heart disease
- Lower risk of different cancers, coronary heart disease and diabetes

Consequences of barley use: previous studies


- **Organoleptic characteristics in bread** (Shfali Dhingra and Jood, 2002)

- **Physical properties and acceptability of pita bread, cakes or cookies** (Ragaee and Abdel-Aal, 2006)

- **Nutricional properties** (Trogha et al, 2004; Vasanthan et al, 2002; Gill et al, 2002; Ragaee and Abdel-Aal, 2006)
**Instrumental and sensory consumer evaluation of 3 different pan breads samples:**

- white pan bread (100% wheat flour) and two supplemented barley breads
Flours composition

- A strong commercial wheat flour (100 W)  
  And two flour blends consisting of:

- 85% wheat flour and 15% barley flour: (85W/15B)

- 70% wheat flour and 30% barley flour: (70W/30B)

Barley flour (11.87% protein (dm), 1.08% ash (dm))
HARINAS ESTEBAN, S.A. , Valladolid, España
Dough rheology

- **Chopin Alveograph** (ICC-No. 121: Method for using the Chopin Alveograph).

- **Chopin Consistograph** (ICC No. 171: Determination of the water absorption capacity of wheat flours and of physical properties of wheat flour dough using the Consistograph)

- **Falling Number** (ICC No. 107: Determination of the "Falling Number" according to Hagberg-Perten as a Measure of the Degree of Alpha-Amylase Activity in Grain and Flour)
Baking performances
using a fixed hearth bread baking process, in which

- 100 g (14% moisture basis) of wheat flour (control sample) or blended flour
- 1,1g active dry yeast (Saff Instant de Lesaffre)
- 1.8 g salt
- 59% water absorption
- Barley malt necessary for FN: 250 sec

- mixing time until correct dough development
- Fermentation: 38 °C, 80%RH, time: 2 h
Instrumental evaluation of breads

For each blend, 3 batches of dough were prepared. For each batch of dough 4 pan breads were baked.

**MATERIALS AND METHODS**

<table>
<thead>
<tr>
<th>TEST</th>
<th>Single Cycle</th>
<th>Compression of height: 8 mm</th>
<th>Pre Test Speed: 1 mm/s</th>
<th>Test Speed: 0,5 mm/s</th>
<th>Post Test Speed: 10 mm/s</th>
<th>Diameter of the Probe: 7 cm</th>
</tr>
</thead>
</table>

Crumbs firmness on days 1, 4 and 7

\[
SV = \frac{\text{loaf volume (cm}^3\text{)}}{\text{loaf weight (g)}}
\]
Sensory consumer tests of breads

- 2 pieces of pan bread of different slices/sample.
- 84 consumers (36 men and 48 women) of different age and frequency of consumption.
- Each consumer performed 2 sessions of hedonic tests.
  - First session: blind hedonic tests.
  - Second session: barley breads labelled as “containing functional ingredients”.
  - The order of presentation of the samples was random and counterbalanced.

- 9-points hedonic scale.
  - Like extremely
  - Like very much
  - Like moderately
  - Like slightly
  - Neither like nor dislike
  - Dislike slightly
  - Dislike moderately
  - Dislike very much
  - Dislike extremely

Materials and Methods

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- Each consumer performed 2 sessions of hedonic tests.
  - First session: blind hedonic tests.
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**Statistical analyses**

- **Balanced Analysis of Variance** ($\alpha = 0.05$)

- **Means comparison**
  - Bonferroni
  - LSD

- **Instrumental evaluation**
  - 1 way fixed effect: **breads**

- **Sensory consumer evaluation**
  - 4 ways fixed effects

**Statistical software:** STATGRAPHICS
## Dough rheology

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>P</th>
<th>L</th>
<th>P/L</th>
<th>W</th>
<th>Degradación</th>
<th>P´(%)</th>
<th>W´(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 W</td>
<td>114</td>
<td>87</td>
<td>1.31</td>
<td>370</td>
<td>25.4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>85W/15B</td>
<td>127</td>
<td>63</td>
<td>2.01</td>
<td>307</td>
<td>15</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>70W/30W</td>
<td>129</td>
<td>43</td>
<td>2.99</td>
<td>220</td>
<td>7.7</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>

### Chopin Alveograph

### Chopin Consistograph

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>CH Consistogram</th>
<th>AH Consistogram</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HYD 2200 (%)</td>
<td>Pr Max (mb)</td>
</tr>
<tr>
<td>100 W</td>
<td>54.9</td>
<td>3,036</td>
</tr>
<tr>
<td>85W/15B</td>
<td>54.2</td>
<td>2,879</td>
</tr>
<tr>
<td>70W/30W</td>
<td>52.9</td>
<td>2,578</td>
</tr>
</tbody>
</table>

Knuckles *et al.*, 1997; Wang y Rosell, 2002; Callejo *et al.*, 2008; Sudha *et al.*, 2007
## Instrumental evaluation of breads

### Specific Volume (cm³/g)

<table>
<thead>
<tr>
<th>Day</th>
<th>SAMPLE</th>
<th>P-value</th>
<th>Estimated mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100W</td>
<td>3.18</td>
<td>3.18</td>
</tr>
<tr>
<td></td>
<td>85W/15B</td>
<td>2.42</td>
<td>2.42</td>
</tr>
<tr>
<td></td>
<td>70W/30B</td>
<td>2.26</td>
<td>2.26</td>
</tr>
</tbody>
</table>

Knuckles et al., 1997; Gill et al., 2002; Ragaee y Abdel-Aal (2006)
# Instrumental evaluation of breads

**Hardness (g) and Increases on Hardness (%)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Day</th>
<th>SAMPLE</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>100W</td>
<td>3,547</td>
</tr>
<tr>
<td></td>
<td></td>
<td>85W/15B</td>
<td>5,454</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70W/30B</td>
<td>10,574</td>
</tr>
<tr>
<td>Estimated mean</td>
<td></td>
<td></td>
<td>0.0000</td>
</tr>
<tr>
<td>Hardness (g)</td>
<td>[1-4]</td>
<td>69</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td></td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>Increases on Hardness (%)</td>
<td>[1-7]</td>
<td>106</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td></td>
<td>112</td>
<td></td>
</tr>
</tbody>
</table>

Increases on Hardness (%) [1-4] = \((H4-H1)/H1\)*100.

Increases on Hardness (%) [1-7] = \((H7-H1)/H1\)*100.

# Sensory consumer tests

## Analysis of Variance for hedo - Type III Sums of Squares

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN EFFECTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A:pan</td>
<td>6,68254</td>
<td>2</td>
<td>3,34127</td>
<td>1,49</td>
<td>0,2254</td>
</tr>
<tr>
<td>B:info</td>
<td>2,57143</td>
<td>1</td>
<td>2,57143</td>
<td>1,15</td>
<td>0,2841</td>
</tr>
<tr>
<td>C:edad</td>
<td>26,8157</td>
<td>3</td>
<td>8,93858</td>
<td>4,00</td>
<td>0,0079</td>
</tr>
<tr>
<td>D:sexo</td>
<td>12,549</td>
<td>1</td>
<td>12,549</td>
<td>5,61</td>
<td>0,0182</td>
</tr>
<tr>
<td>RESIDUAL</td>
<td>1109,14</td>
<td>496</td>
<td>2,23616</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL (CORRECTED)</td>
<td>1161,61</td>
<td>503</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### According to age:

1: < 20 years old  
2: 20-35 years old  
3: 36-50 years old  
4: 51-65 years old

### According to sex:

- Men: 6,3, 6,2, 6,1, 6  
- Women: 6,4, 6,3, 6,2, 6,1

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**RESULTS AND DISCUSSION**
**Instrumental evaluation**

1. **Significant differences** among the three breads (control pan wheat bread and the two barley flour supplemented breads) in **specific volume** and **crumb firmness** evaluated **24 hours** after baking were found.

2. From the **staling** point of view, evaluated on the basis of the evolution of the increase on firmness over 7 days, **no statistically significant differences** were found among the three breads neither between days 1 and 4, neither between days 4 and 7.

**Sensory consumer evaluation**

3. **No significant differences** were found on the **hedonic ratings** of the three breads.

4. **Information** about the positive functional properties of barley breads had **no significant effect** on the hedonic evaluation by consumers.

5. **Significant differences** by **sex** and **age** of consumers on the hedonic evaluation of breads were found.
HEALTHIER CEREAL PRODUCTS:
BREADMAKING WITH BARLEY FLOUR
Callejo, M.J., Chaya, C., Bujeda, C. and Rodríguez, G., 2008 Instrumental evaluation of rheological properties of rye flour added doughs Unsubmitted paper


